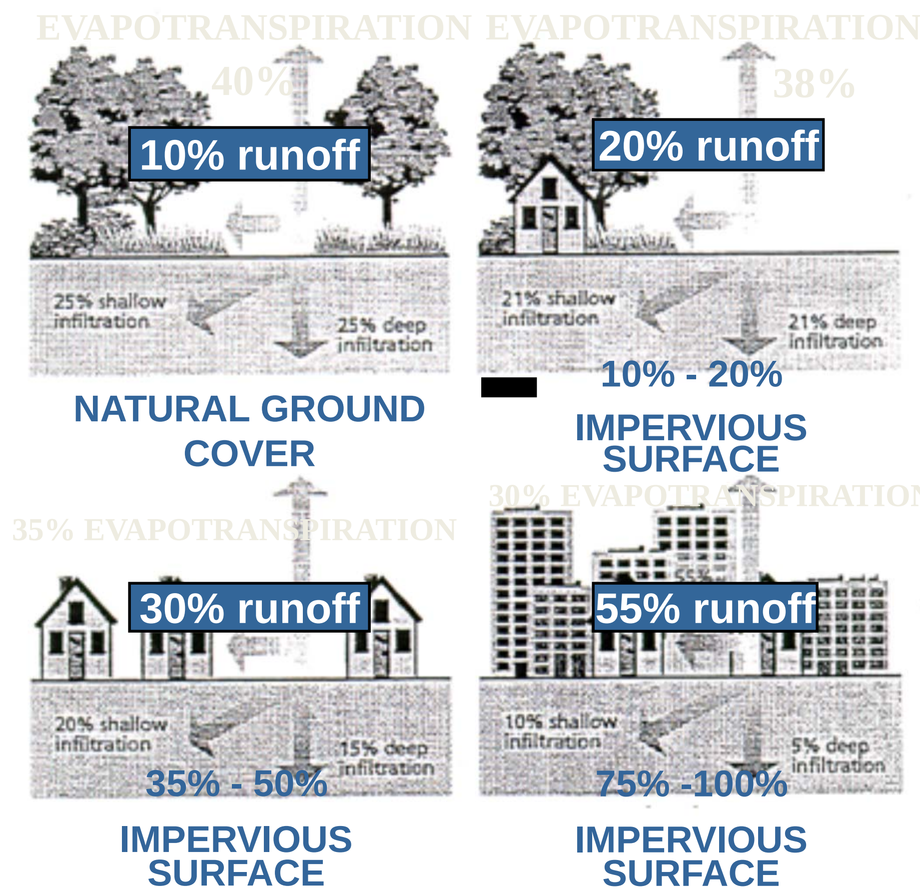
Regenerative Stormwater Conveyance and Integrated Stream and Wetlands Ecosystem Restoration

Problems

- Traditional Stormwater Management
- Legacy Sediments
- Incorrect Models

RELATIONSHIP BETWEEN IMPERVIOUS COVER AND SURFACE RUNOFF

- Impervious cover in a watershed results in increase surface runoff.
- As little as 10 percent impervious cover in a watershed can result in stream degradation.



Riva
400

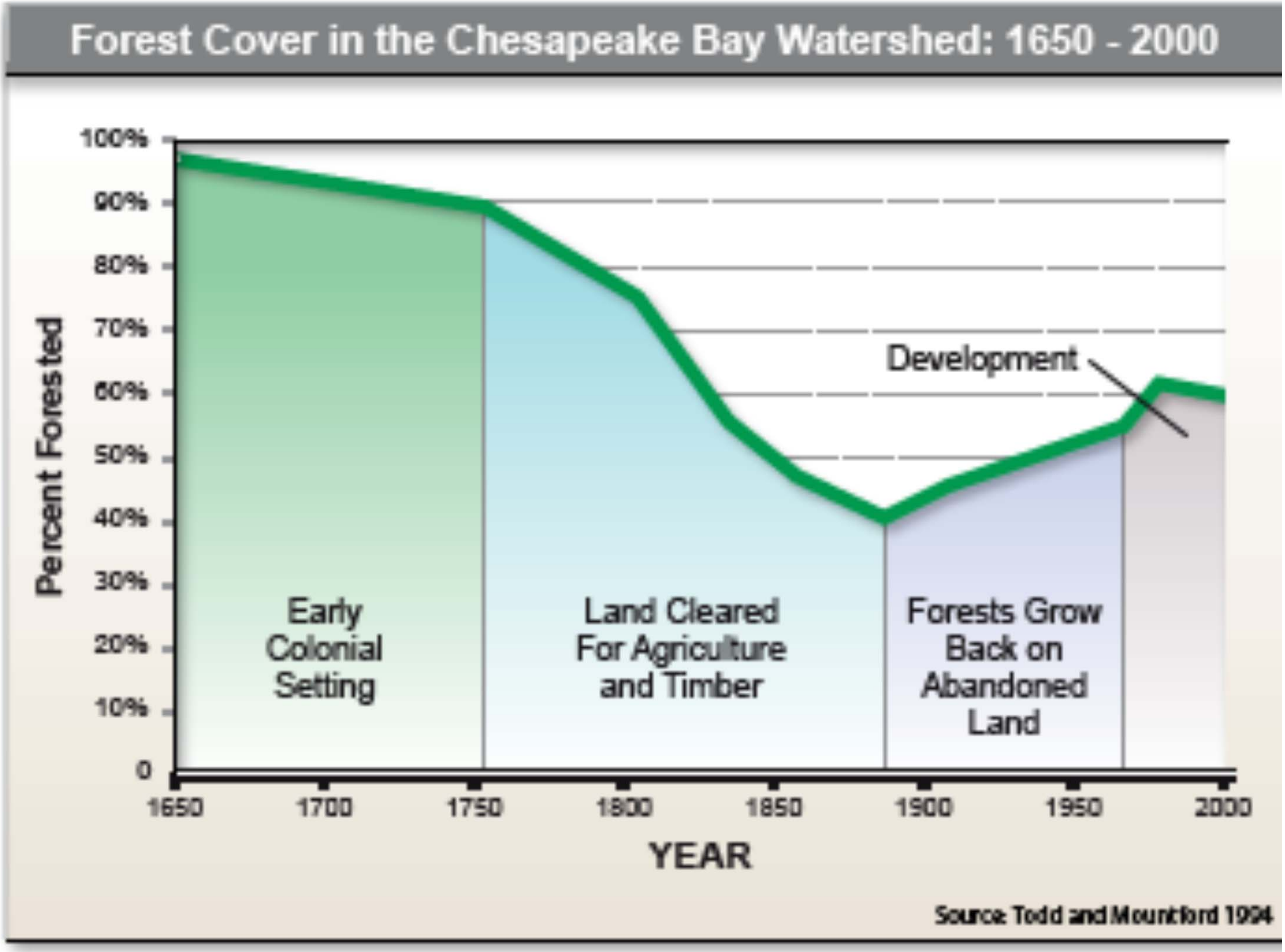

Forest Cover in the Chesapeake Bay Watershed: 1650 - 2000
Percent Forested
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0
Early Colonial Setting
Land Cleared For Agriculture and Timber
Forests Grow Back on Abandoned Land
Development
1650
1700
1750
1800
1850
1900
1950
2000
YEAR
Source: Todd and Mountford 1994

Photo: McCain Printing Company

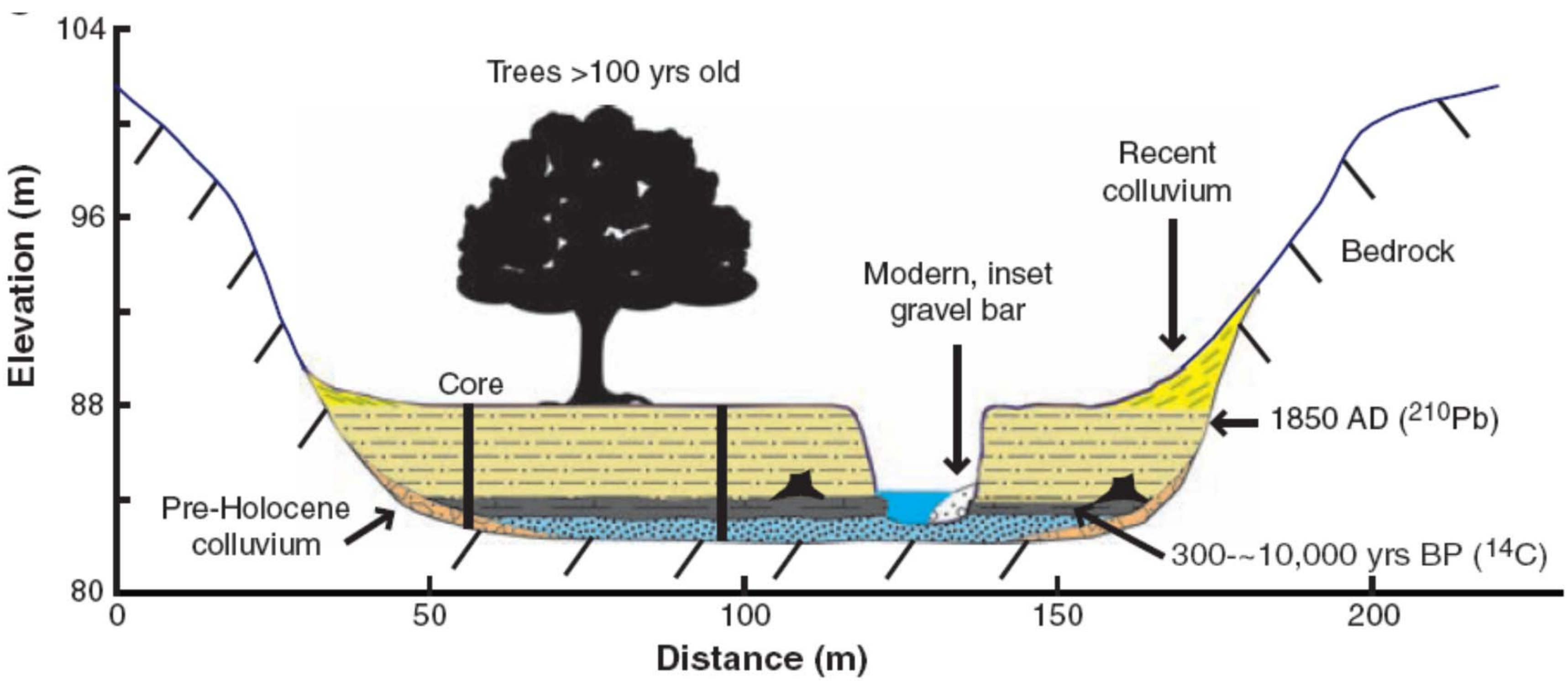
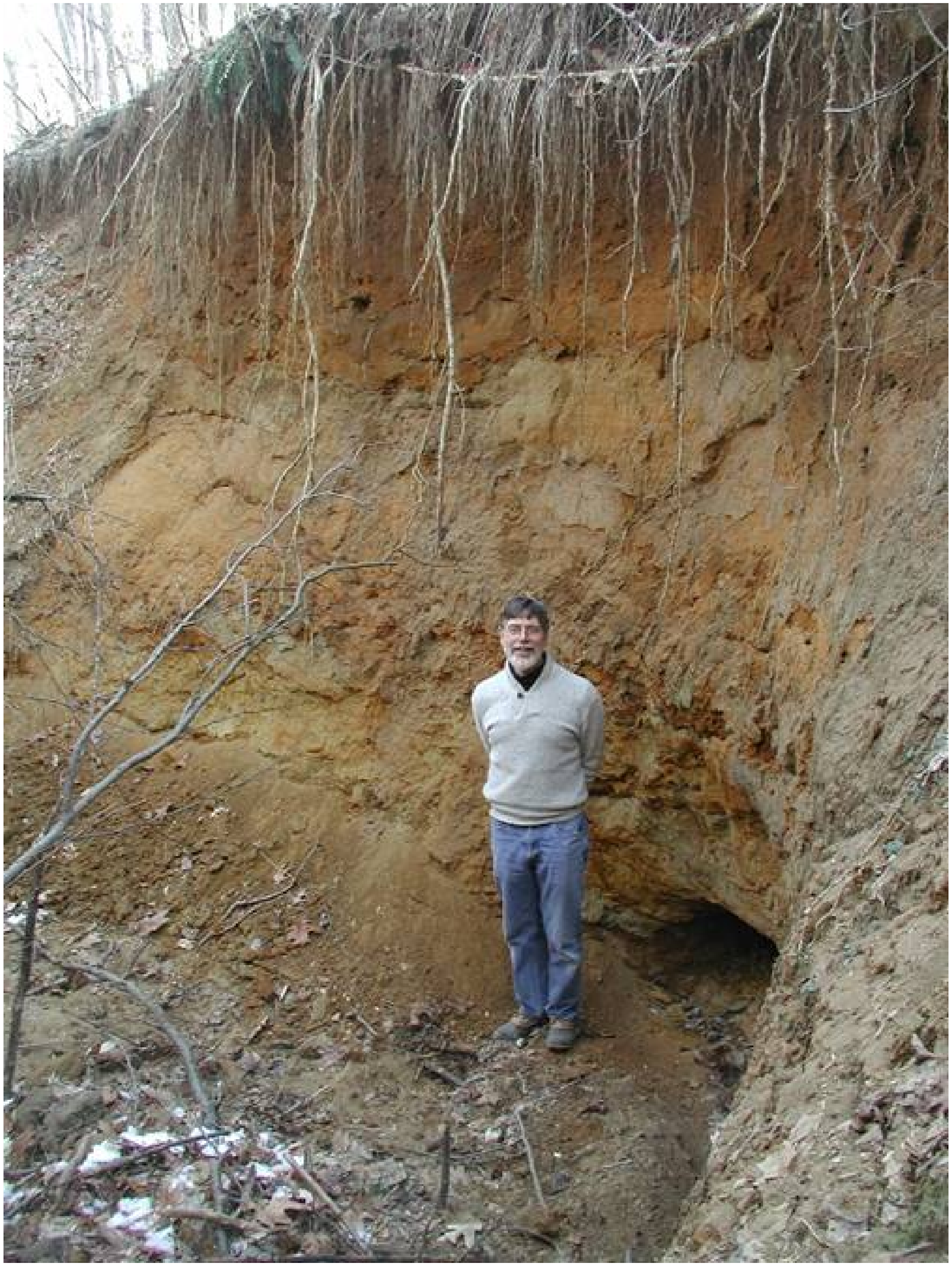


Fig. 3. Streams throughout the mid-Atlantic region (see also figs. S1 and S2) have similar characteristics: vertical to near-vertical banks consisting of 1 to 5 m of laminated to massive fine-grained sediment overlying a Holocene hydric soil and a basal gravel overlying bedrock. (**A**) Western Run, Maryland. (**B**) Big Spring Run, Pennsylvania. Scale bars in (A) and (B) are marked in 0.5-m increments; the banks in (A) and (B) are ~2.2 and ~1.4 m high, respectively. (**C**) Conceptual model based on composite stratigraphy from multiple sites, including stream-bank exposures, trenches, and cores.

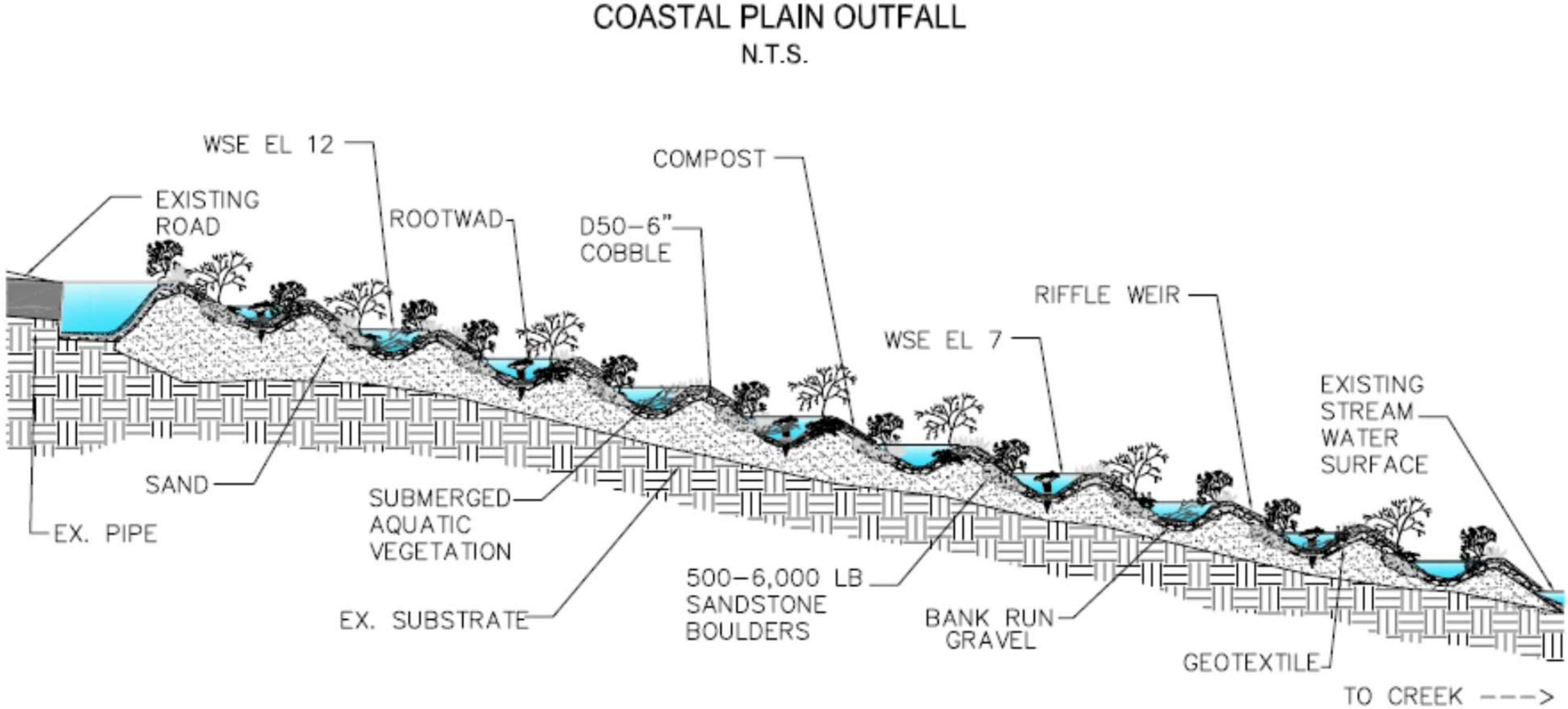


Carriage Hills
Previous Condition
-
Construction
Began
December 2009

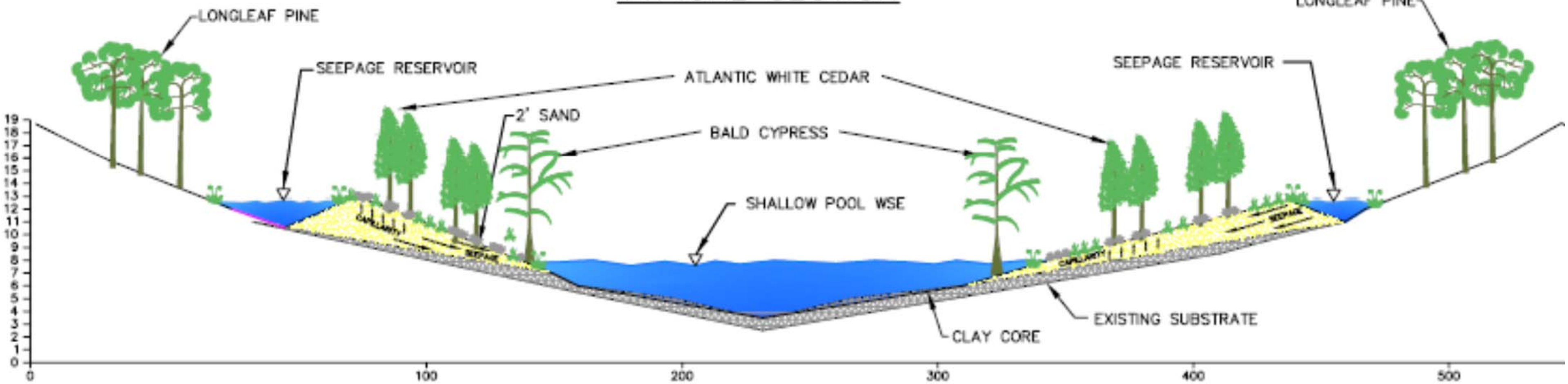
Glen Oban

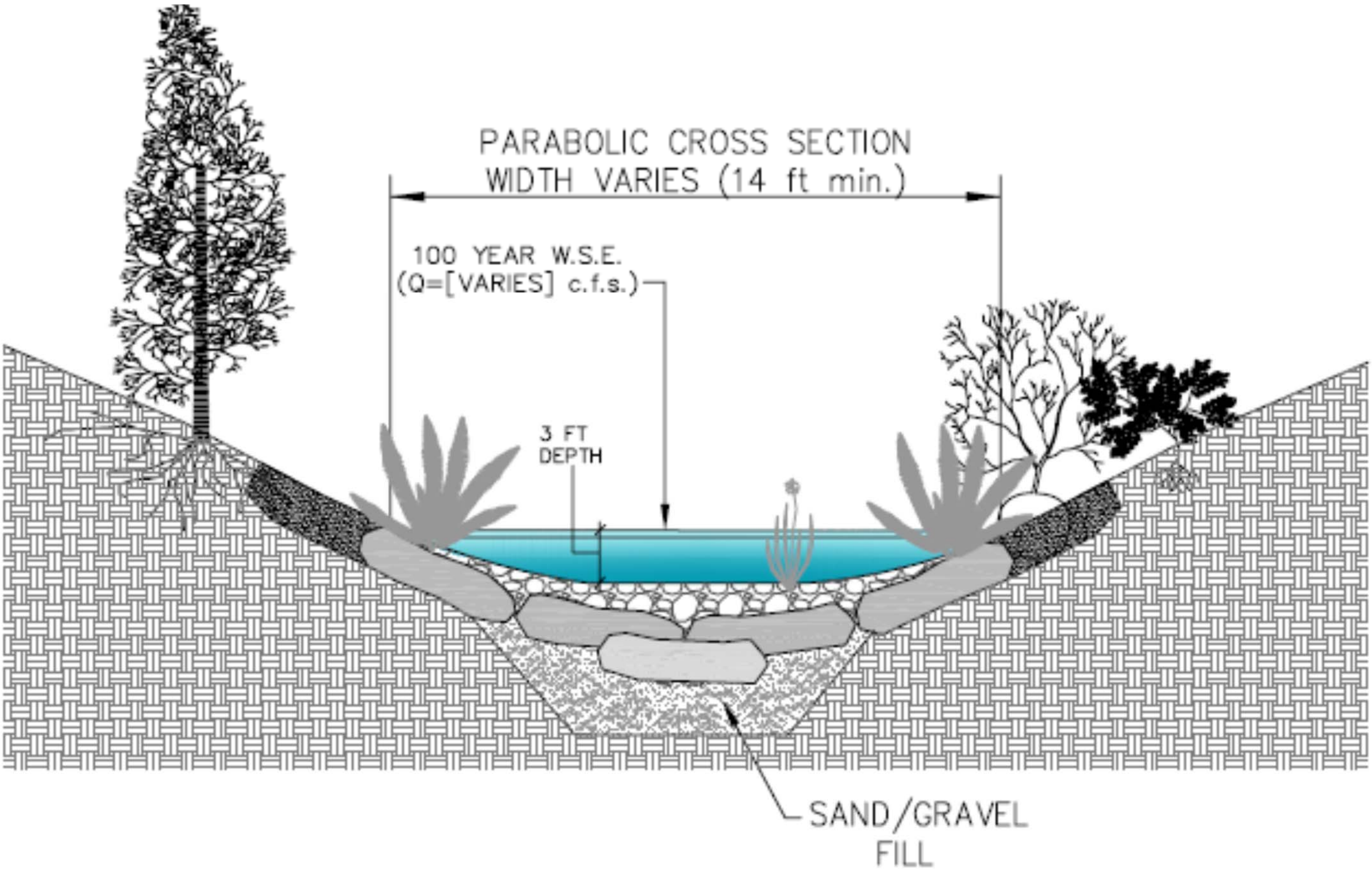
Basic Building Blocks

Regenerative Stormwater Conveyance

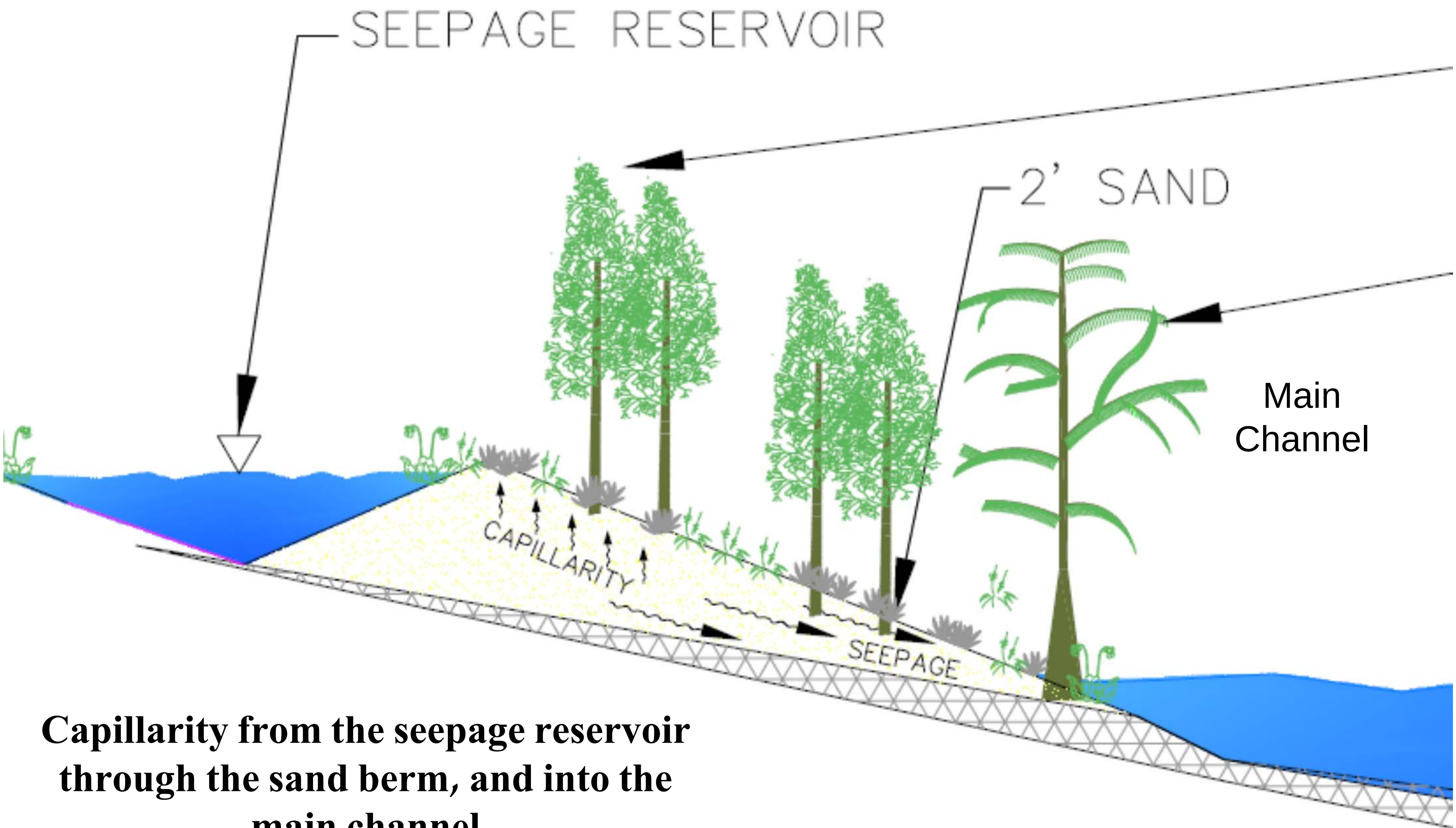


SEEPAGE WETLAND TYPICAL SECTION

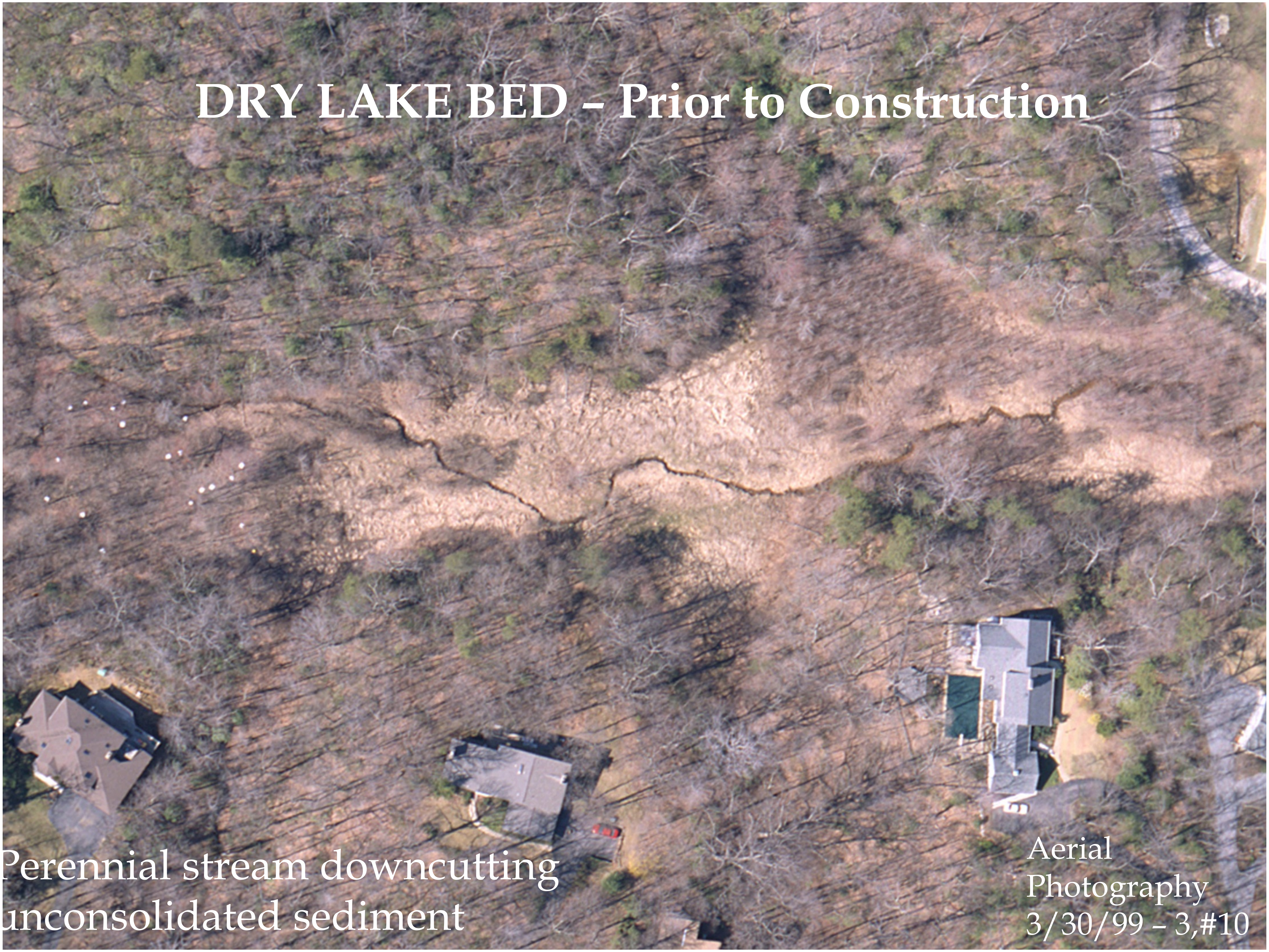


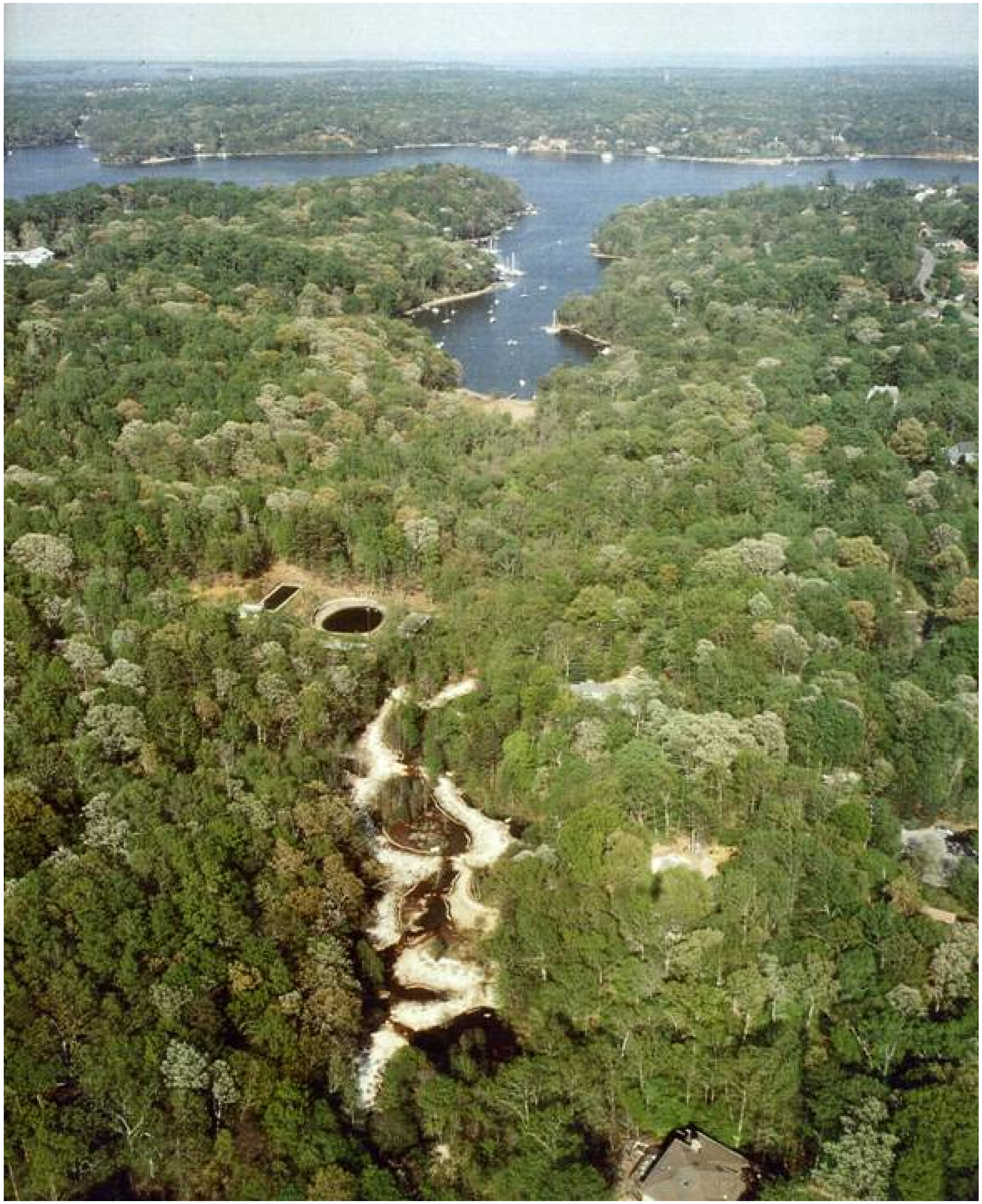

PARABOLIC CROSS SECTION
WIDTH VARIES (14 ft min.)
100 YEAR W.S.E.
(Q=[VARIES] c.f.s.)
3 FT
DEPTH
SAND/GRAVEL
FILL

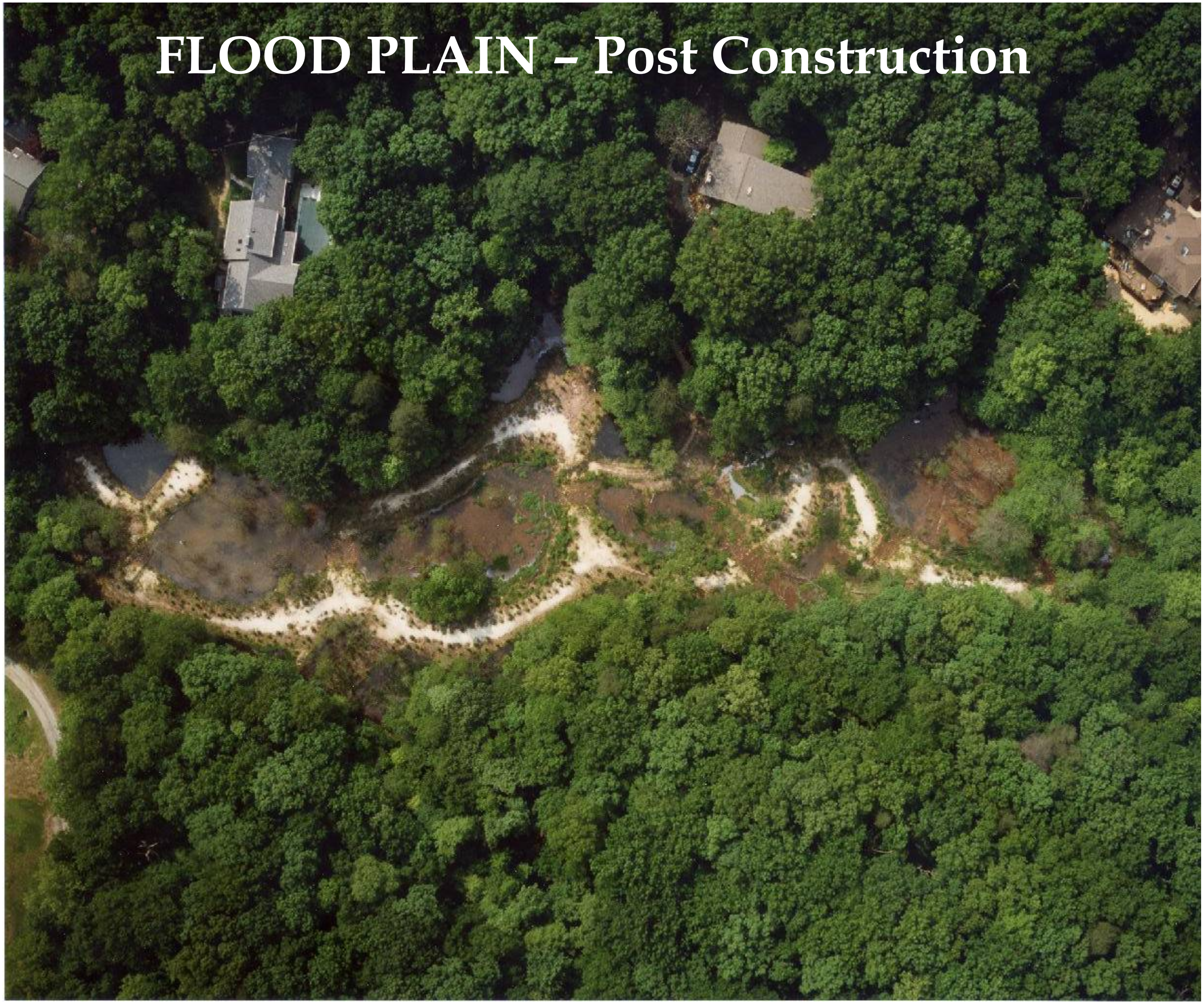
The Sand Seepage Feature



Capillarity from the seepage reservoir through the sand berm, and into the main channel

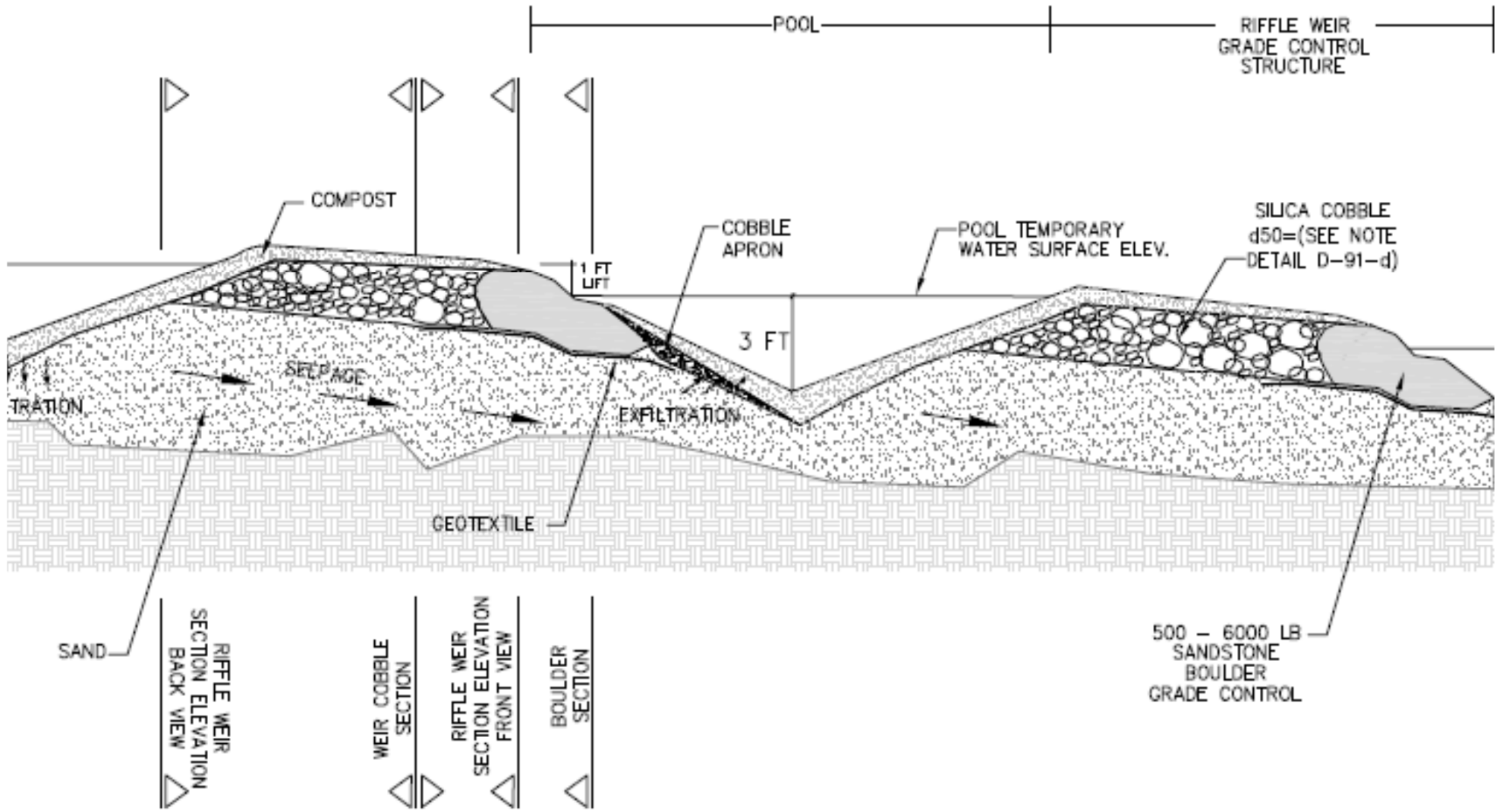

DRY LAKE BED – Prior to Construction
Perennial stream downcutting
unconsolidated sediment
Aerial
Photography
3/30/99 – 3,#10



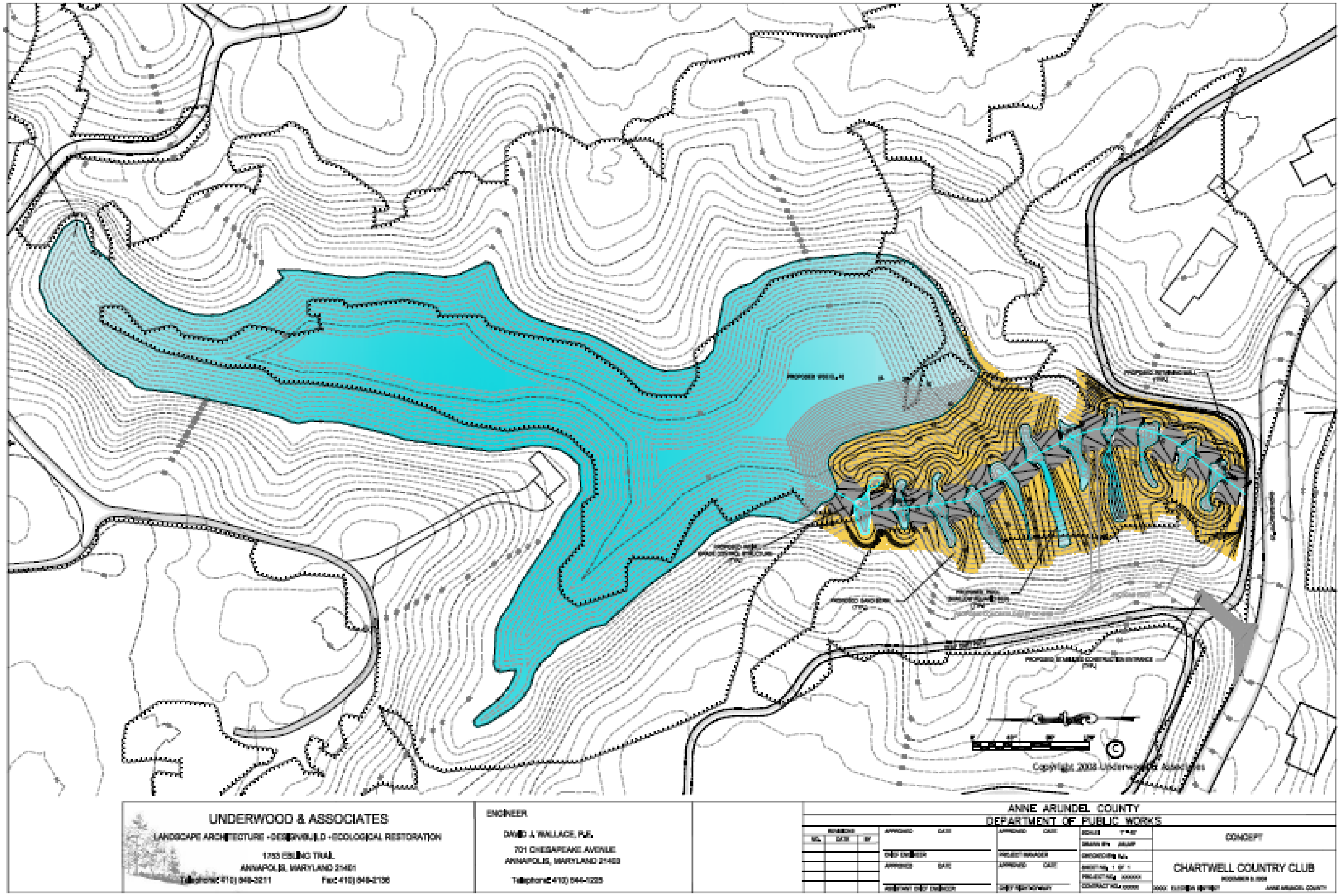

FLOOD PLAIN – Post Construction


Infiltration increases baseflow

Riffle Pool Profile Section



Proposed RSC Design



Coastal Plain Outfalls

- dissipate existing stormwater discharge energies
- provide in-situ water quality treatment
- manage stormwater quantities in-situ
- use natural material native to the coastal plain
- can be designed with public access for educational purposes
- re-establish a natural, aesthetically pleasing, self-sustaining coastal plain stream valley

The Restoration Plan

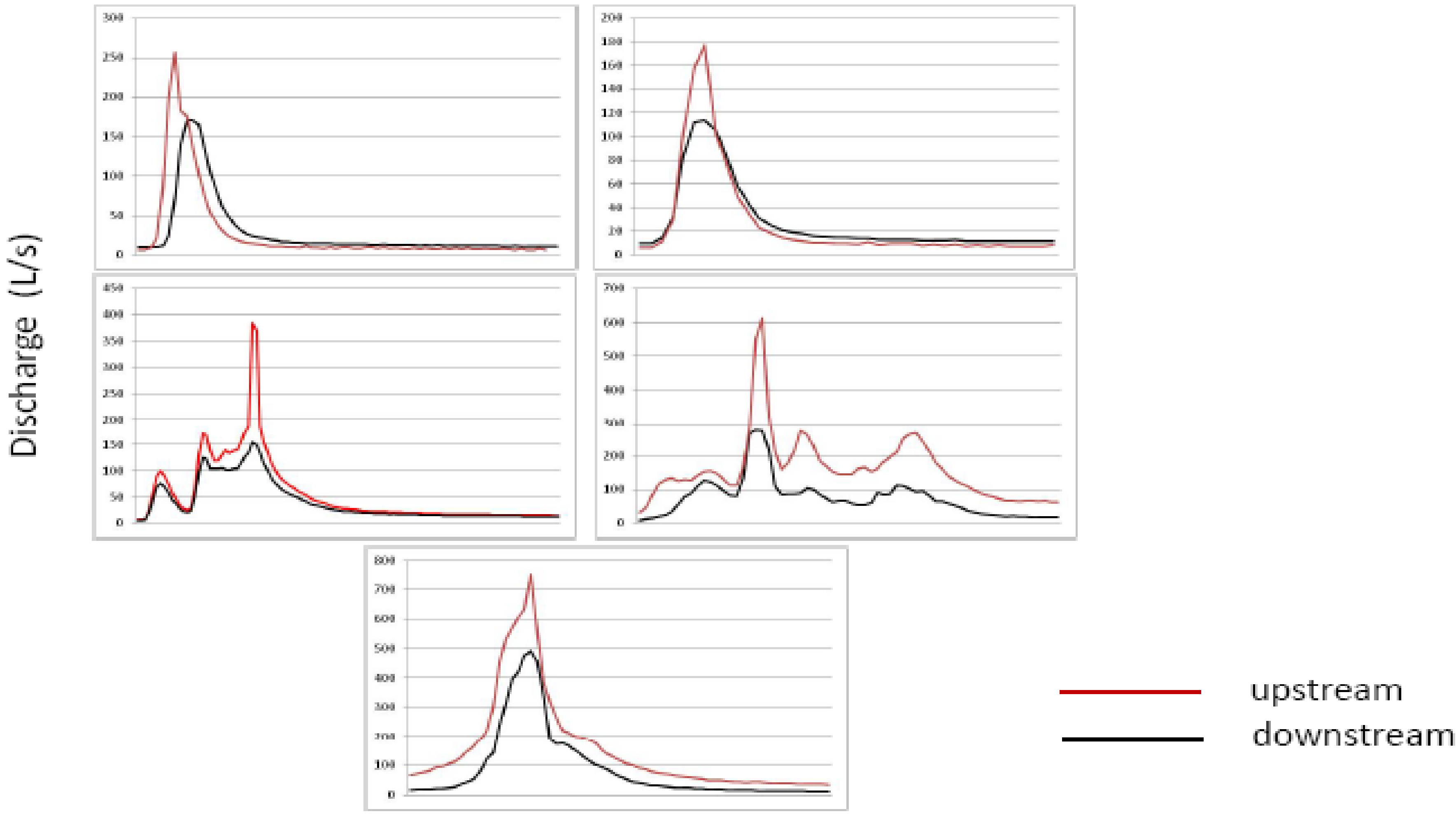
- Technique
  - Placement of network of sand berms
  - Creation of "moat" along toe of slope
  - Creation of sand and woodchip substrate
  - Step pool reach with ferracrete/limonite
- Purpose
  - Facilitates formation of seepage gradient
  - Supports lateral seepage through sand berms
  - Establish soil to support AWC
  - Transition to off-site incised channel

The Restoration Plan

- Technique
  - Raise channel invert with quartz cobble
  - Controlled water surface elevations with cobble weirs
  - Ponded stream reaches dissipate energy and trap sediments
- Purpose
  - Raise groundwater table to support wetland hydrology
  - Provide head to support seepage through substrate
  - Support accretion of sediment and development of peat


Bishopville Pond –
Fish Passage

Hydrographs during individual storms
HOWARD'S BRANCH



Source: Solange Filoso, University of Maryland

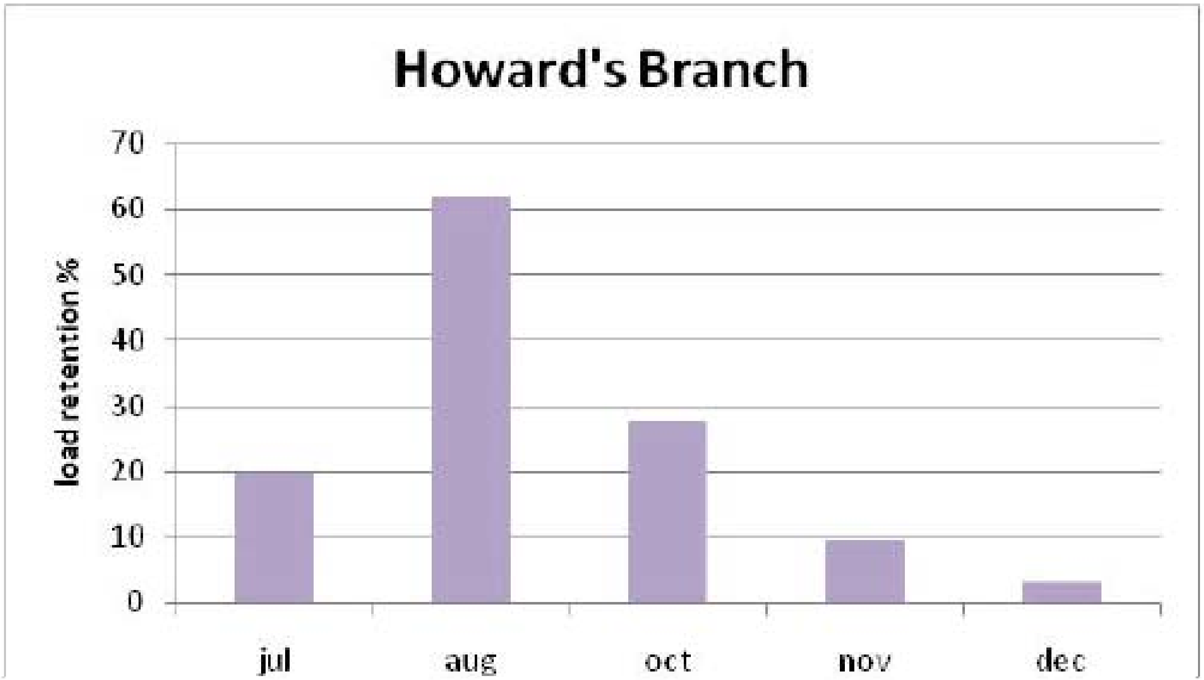


Figure 32. Percent load reduction of TN in the restored reach of Howard's Branch during five different storm events.

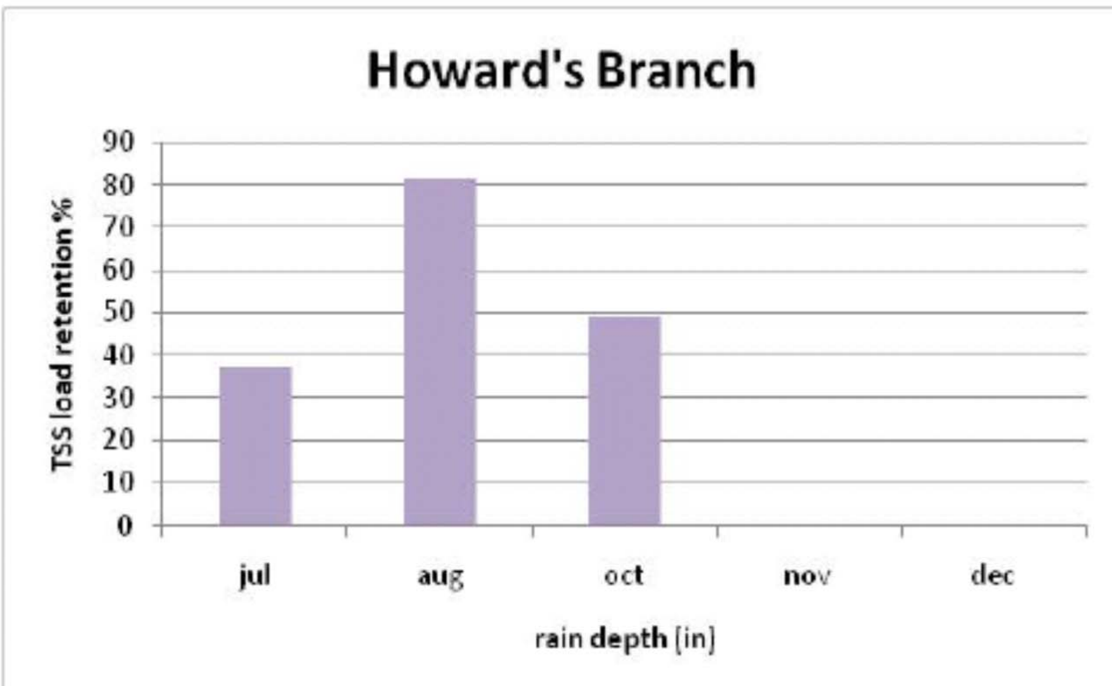
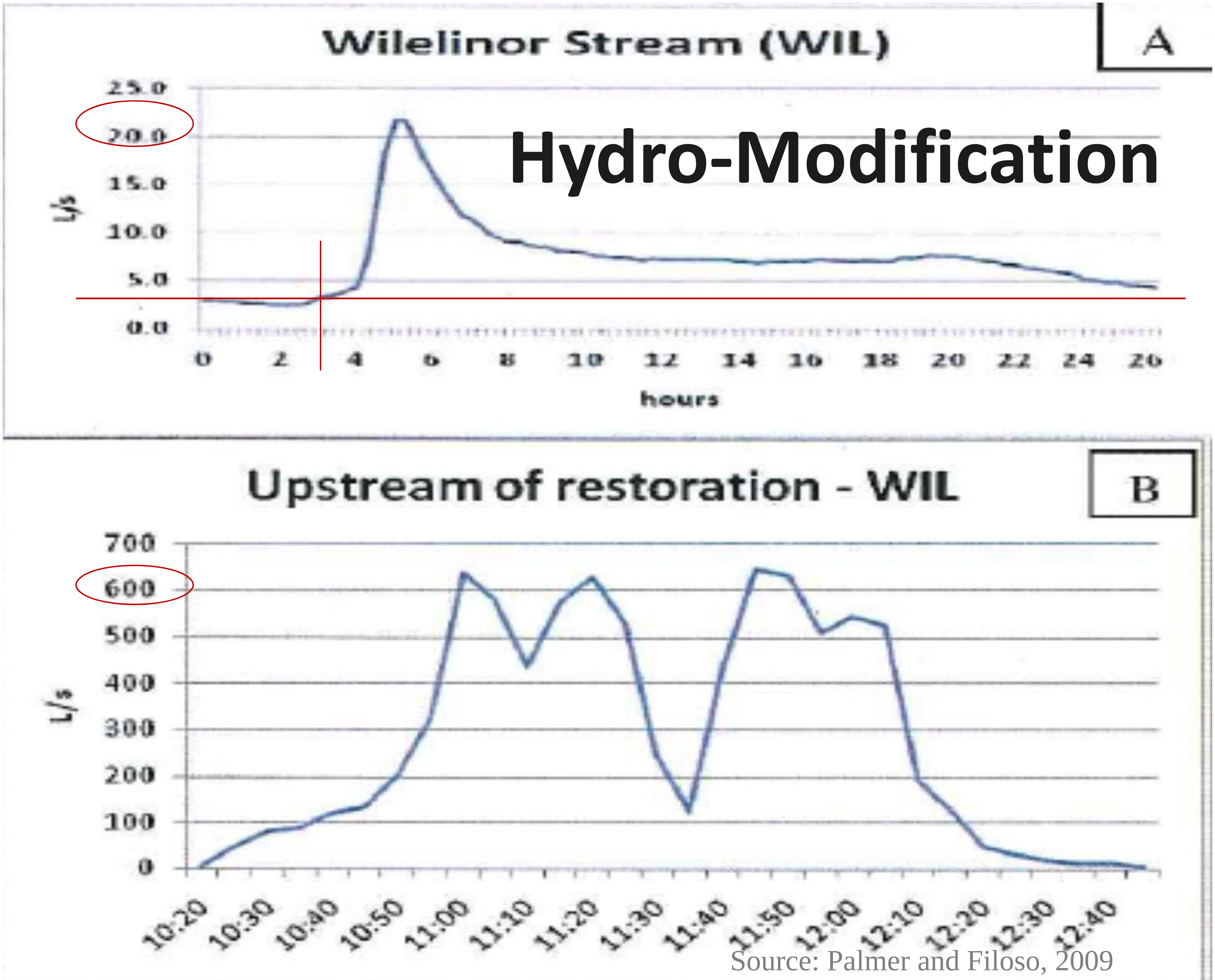


Figure 34. Percent load reduction of TSS in the restored reach of Howard's Branch during five different storm events.

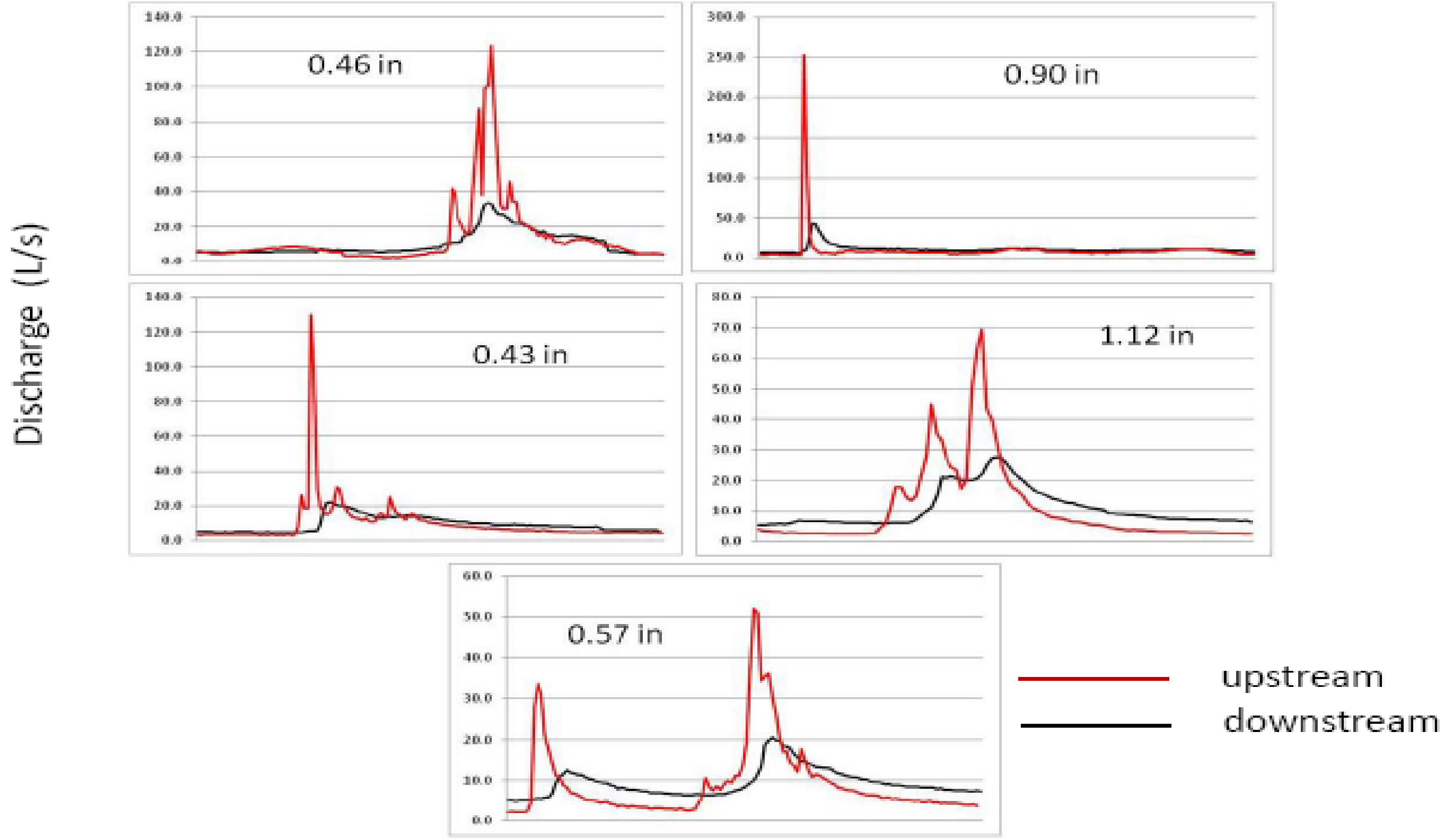
Source: Palmer and Filoso, 2009

Hydro-Modification

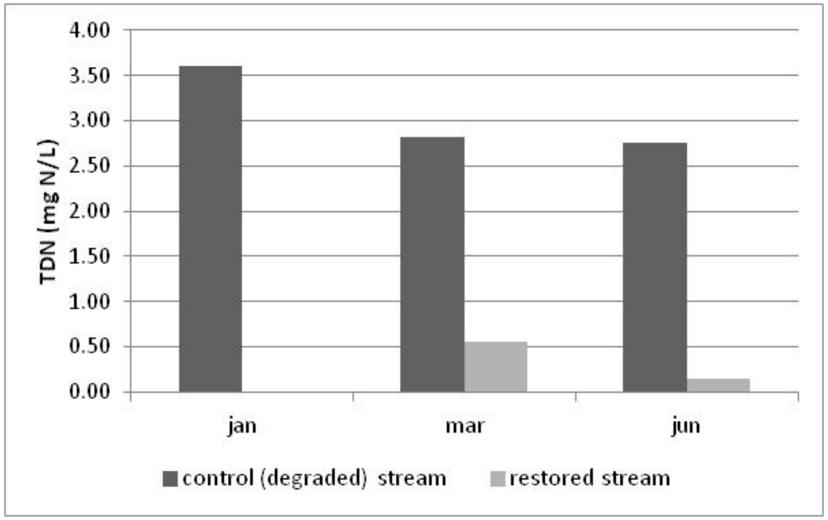


Source: Palmer and Filoso, 2009

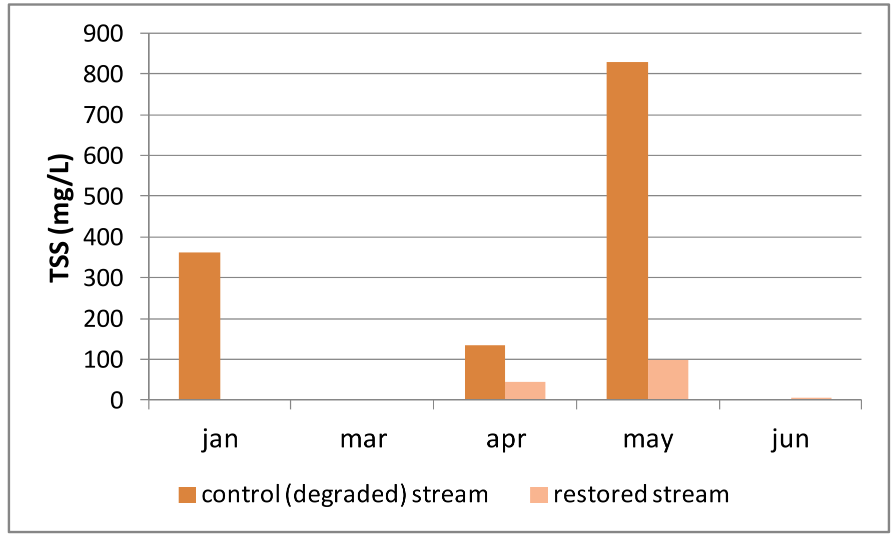
Hydrographs during individual storms WILELINOR



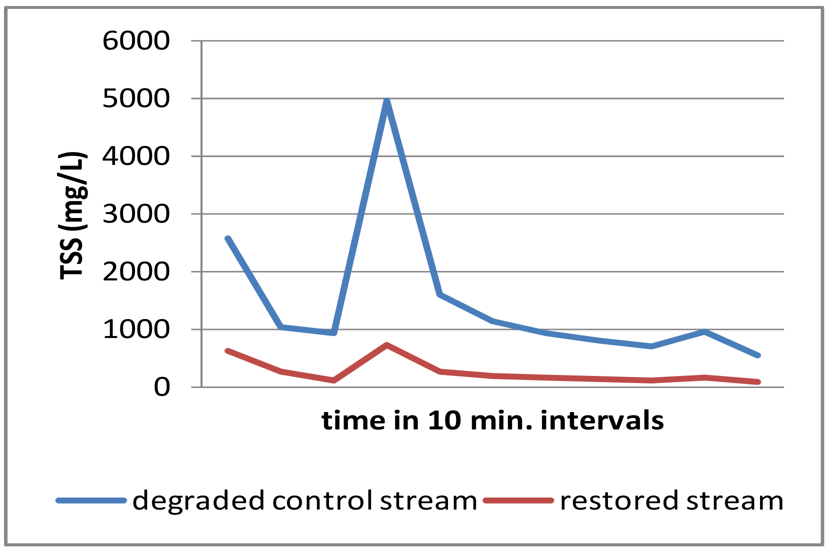
Source: Solange Filoso, University of Maryland



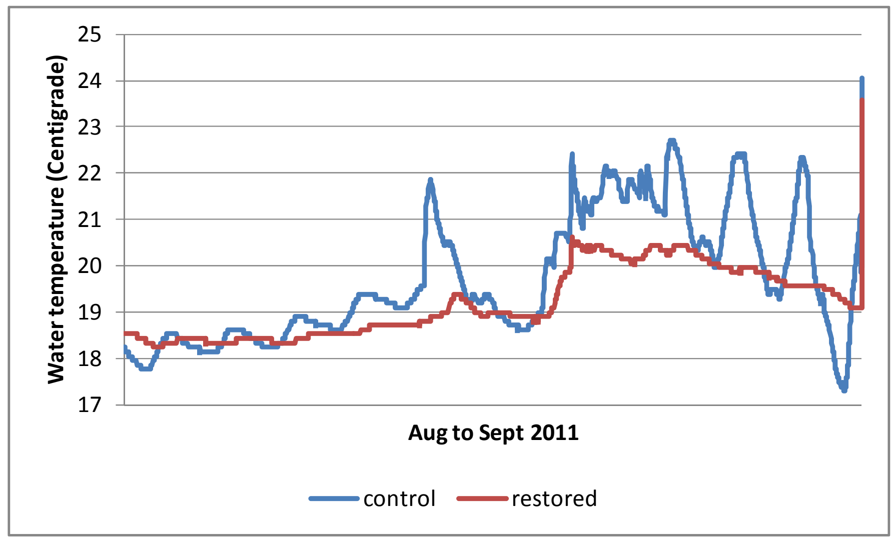
TDN (mg N/L)
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
jan
mar
jun
control (degraded) stream
restored stream



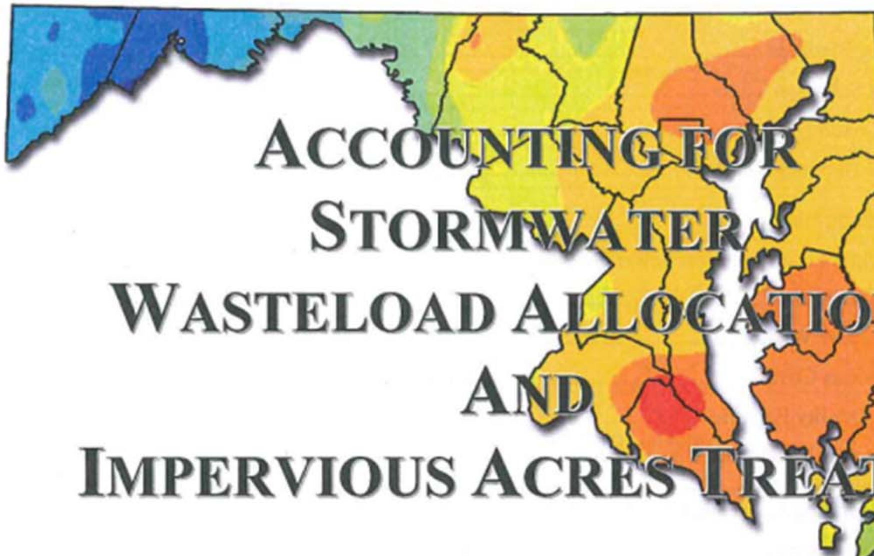
TSS (mg/L)
900
800
700
600
500
400
300
200
100
0
jan
mar
apr
may
jun
control (degraded) stream
restored stream



TSS (mg/L)
6000
5000
4000
3000
2000
1000
0
time in 10 min. intervals
degraded control stream
restored stream



Water temperature (Centigrade)
25
24
23
22
21
20
19
18
17
Aug to Sept 2011
control
restored



ACCOUNTING FOR STORMWATER WASTELOAD ALLOCATIO AND IMPERVIOUS ACRES TREA

GUIDANCE FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION STORMWATER PERMITS

JUNE (DRAFT) 2011

MARYLAND
DEPARTMENT OF THE ENVIRONMENT

1800 Washington Boulevard | Baltimore, MD 21230-1718 | www.mde.state.md
410-537-3000 | 800-633-6101 | TTY Users: 800-735-2258
MARTIN O'MALLEY, *GOVERNOR* | ANTHONY G. BROWN, *LT. GOVERNOR* | ROBERT M. SUMMERS,

Table 4. Structural BMP Retrofit Matrix

BMP Practice	TN	TP	TSS
CBP Structural BMPs			
Dry Detention Ponds	5%	10%	10%
Hydrodynamic Structures	5%	10%	10%
Dry Extended Detention Ponds	20%	20%	60%
Wet Ponds and Wetlands	20%	45%	60%
Infiltration Practices	80%	85%	95%
Filtering Practices	40%	60%	80%
Vegetated Open Channels	45%	45%	70%
Erosion and Sediment Control	25%	40%	40%
Stormwater Management by Era			
Development Between 1985 - 2002	17%	30%	40%
Urban BMP Retrofit	25%	35%	65%
Development Between 2002 and 2010	30%	40%	80%
Development After 2010	50%	60%	90%
ESD to the MEP from the *Manual*			
Green Roofs	50%	60%	90%
Permeable Pavements	50%	60%	90%
Reinforced Turf	50%	60%	90%
Disconnection of Rooftop Runoff	50%	60%	90%
Disconnection of Non-Rooftop Runoff	50%	60%	90%
Sheetflow to Conservation Areas	50%	60%	90%
Rainwater Harvesting	50%	60%	90%
Submerged Gravel Wetlands	50%	60%	90%
Landscape Infiltration	50%	60%	90%
Infiltration Berms	50%	60%	90%
Dry Wells	50%	60%	90%
Micro-Bioretention	50%	60%	90%
Rain Gardens	50%	60%	90%
Grass, Wet, or Bio-Swale	50%	60%	90%
Enhanced Filters	50%	60%	90%
Additional Structural BMP Guidance			
Redevelopment (MDE)	50%	60%	90%
Existing Roadway Disconnect (MDE)	50%	60%	90%
Step Pool Storm Conveyance (MDE)	50%	60%	90%